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SECTION 5: TECHNOLOGICAL ATTAINABILITY OF THE NEW AND REFINED DESIGNATED USES

This section addresses the technological attainability of the proposed new and refined designated uses. It should be noted that a UAA providing justification for new or refined designated uses, particularly for areas where the uses will be more stringent than current ones, is, according to a strict interpretation of the regulations, not required, but the Bay Program's WQSC agreed that it is a logical extension of this effort.

Section 4 presents the proposed new and refined designated uses and their boundaries delineated on the basis of physical conditions, bathymetric features and insights into natural conditions vs. anthropogenic influences through the analysis of Bay water quality monitoring data. The next step is to determine whether the criteria set to protect each of these designated uses can be achieved throughout each use's proposed boundaries strictly on the basis of technological implementation of nutrient and sediment controls.

This section compares the proposed scientifically derived designated use boundaries, as delineated in Section 4, to estimates of the Chesapeake Bay watershed's technological capability in achieving these designated uses. A series of level of effort scenarios (or tiers) has been developed that estimate the nutrient and sediment reductions resulting from the implementation of various BMPs and control technologies. The tier scenarios were simulated by the Bay Program's Phase 4.3 Watershed Model and the resultant loads for nitrogen, phosphorus, and sediment were used as inputs to the Chesapeake Bay Estuary (water quality) Model. Ambient DO concentrations was then determined by the Estuary Model according to the applicable criteria in each new and refined designated use. Finally, a series of "attainability tables" were derived from the results of the water quality model analyses which provide an indication of where the DO criteria, per new and refined designated use, is, and is not, attained in the tidal portions of the Bay. This section provides the results of these analyses

The attainability analyses were performed only with respect to the DO criteria proposed for each designated use. The current draft of this TSD does not evaluate attainability with respect to the proposed clarity or chlorophyll *a* criteria. However, the Bay Program plans to address clarity and chlorophyll *a* in the April 2003 version of this document. Finally, this section provides information on further analyses that can be used to determine attainability that were not completed at the time of this writing, but are intended to be performed during the public comment period.

5.1 DETERMINING TECHNOLOGICAL ATTAINABILITY

This section describes the nutrient and sediment reduction tiers in terms of their respective BMP and control technologies and their load reductions. The water quality response realized by the theoretical implementation of each tier is estimated, and then an assessment is made of whether this water quality response is sufficient to attain the DO criteria applicable to each of the proposed new and refined designated uses.

5.1.1 Development of Level-of-Effort Scenarios

The Chesapeake Bay Program developed a series of level of effort scenarios to represent the watershed's nutrient and sediment reduction potential in terms of types, extent of implementation, and performance of BMPs, wastewater treatment technologies, and storm water controls. These level-of-effort scenarios range from Tier 1, which represents current level of implementation throughout the watershed plus regulatory requirements implemented through the year 2010, up to a LOT scenario referred to as E3 which is acknowledged to not be physically plausible in all cases. Two intermediate levels of implementation were also developed, Tier 2 and Tier 3. Each tier has associated with it a given nitrogen, phosphorus and sediment load reduction effected by the different technologies assigned to the tier.

As stressed in the introduction of this document, these tiers are artificial constructs of technological levels of effort and <u>do not represent actual programs the jurisdictions will eventually implement to meet the water quality standards</u>. Rather, the tiers were developed by the Bay Program partners as an *assessment tool* to determine potential load reductions achievable by various levels of technological effort and were modeled to determine water quality responses. Appendix A describes the development of these tiers and the technologies represented by each. Appendix A also presents the results of the Bay Program's Watershed Model which estimates the nitrogen, phosphorus and sediment load reductions resulting from the implementation of the tiers.

The tiers were developed based primarily on the amount of nutrient (nitrogen and phosphorus) reduction afforded by the various actions described in each. Sediment reduction is only estimated so far as it is incidental to nutrient removal BMPs. Other sediment reduction practices are available, and may, if implemented along with nutrient reduction efforts, afford additional water quality improvements (see Section 5.4.1).

An ad-hoc Sediment Reduction Task Force has been assembled by the Chesapeake Bay Program which will investigate sediment reduction BMPs that can be performed in the tidal portions of the Bay. The Task Force will be conducting a workshop in early 2003 to assess a list of tidal specific sediment reduction actions designed to improve water quality in the tidal areas of the Bay. The TSD which is published in April 2003 will thus contain much more complete information than is available at the time of this publication on sediment reduction BMPs and Appendix A will be similarly updated.

EPA solicits comments on the technologies considered and load reductions estimated for these tiers.

The tiered scenarios were defined by the "source" workgroups of the Bay Program's Nutrient Subcommittee. These workgroups are made up of representatives of Bay-watershed jurisdictions and Bay Program office personnel. The specific workgroups that decided BMP and technology implementation levels included the Agricultural Nutrient Reduction Workgroup, the Forestry Workgroup, the Point Source Workgroup, and the Urban Storm Water Workgroup. The

Tributary Strategy Workgroup (TSWG) and Nutrient Subcommittee finalized E3 definitions after review and further deliberation. The tiers were developed for the following source categories:

1. Point Sources
2. Onsite Treatment Systems
3. Nonpoint Source Agriculture
4. Nonpoint Source Urban
5. Nonpoint Source Forests

The following subsections provide a general summary of the technologies selected to enable progressively higher levels of reductions by tier according to the source categories listed above.

Point Sources

A multi-stakeholder NRT Cost Task Force, consisting of federal, state and local governments as well as municipal authority representatives and expert consultants, was formed as a temporary extension of the Chesapeake Bay Program's Nutrient Subcommittee Point Source Workgroup. The Task Force defined what would be logical tiers (or different nutrient reduction levels) for point sources (U.S. EPA, 2002). Using flows estimated/projected for the year 2010, the tiers range from the current (year 2000) treatment levels to the LOT.

The point sources analyzed in this effort include facilities located in the Chesapeake Bay Watershed (from PA, MD, VA, DE, WV, NY, and the District of Columbia), which the Bay jurisdictions have determined discharge significant amounts of nitrogen and phosphorus. These point sources are divided into several categories for purposes of this exercise and include:

- Significant Municipal facilities (which generally are municipal wastewater treatment plants that discharge flows of equal to or greater than 0.5 MGD);

- Significant Industrial facilities (which have been identified to discharge equivalent or greater amounts of nutrient as compared to a municipal wastewater treatment plant of 0.5 MGD);

- Non-significant municipal facilities (which are generally facilities with discharge flows smaller than 0.5 MGD and limited to facilities in MD and VA due to availability of data); and

- CSOs (which for this exercise, includes the CSO for the District of Colombia because this is the only CSO for which the Bay Program has nutrient load data).

Exhibit 5-1 provides a summary description of the levels of nutrient reduction by point source category for each tier.

Exhibit 5-1: Description of Tiers for Point Sources*
(concentrations given in terms of an annual average in mg/l)

Point Source Category	Tier 1	Tier 2	Tier 3	E3
Significant Municipals	TN = 8 for publically owned treatment works (POTW's) operating (or planned) NRT; TN for remainder = 2000 concentrations. TP = 2000 concentrations, except TP = 1.5 at those targeted by VA.	TN = 8; TP = 1.0 or permit limit if less	TN= 5.0; TP = 0.5 or permit limit if less	TN = 3.0; TP = 0.1
Significant Industrials	TN and TP = 2000 concentrations or permit limit if less	Generally a 50% reduction from Tier 1 (2000 concentrations) or permit conditions if less	Generally an 80% reduction from Tier 1 (2000 concentrations) or permit conditions if less	TN = 3.0; TP = 0.1 or permit conditions if less
Non-Significant Municipals	TN and TP = 2000 concentrations	TN and TP = 2000 concentrations	TN and TP = 2000 concentrations	TN = 8 & TP = 2.0 or 2000 concentrations if less
CSOs	43% reduction for Tiers 1–3, zero overflow for E3			

* Note that all flows are in terms of those projected by 2010

For municipal facilities, the technologies for each tier varied depending on the tiers' nutrient reduction levels. For Tier 2, technologies to achieve 8 mg/l TN include extended aeration processes and denitrification zones, along with chemical addition to achieve a TP discharge of 1.0 mg/l where facilities are not already achieving these levels. For Tier 3, technologies to achieve 5.0 mg/l TN include additional aeration, a secondary anoxic zone plus methanol addition, additional clarification tankage, and additional chemical to achieve a phosphorus discharge of 0.5 mg/l. For E3, technologies to achieve 3.0mg/l TN include deep bed denitrification filters and microfiltration to achieve a phosphorus discharge of 0.1 mg/l. Due to seasonal fluctuation, the effluent/discharge levels for each tier were defined as an annual average.

For industries, site-specific information on reductions by facility was obtained via phone contacts or site visits. Tier 1 represents current conditions or plans for reductions that are already in progress. Tier 2 and 3, in general, reflect levels of reduction of 50% and 80% from Tier 1, respectively, unless permit conditions are less than this or site specific information provides alternate data. E3 reflects TN and TP concentrations of 3.0 and 0.1 mg/l respectively unless permit conditions or actual 2000 concentrations are less than this. For E3, some industrial facilities would be incapable of achieving the discharge concentration/level.

The only CSO included in the tiers was that for the District of Columbia because it is the only CSO for which the Bay Program has data on resulting nutrient loads. According to the DC Water and Sewer Authority (WASA), overall nutrient loads are expected to be reduced by 43% from 2000 level over the next 8 years and this is reflected in Tier 1, which is also carried over into Tier 2, and again in Tier 3. For purposes of conceptually estimating limits of technology, zero overflows were assumed for E3 although it is stressed by DC WASA that this is not physically probable.

Onsite Treatment Systems

The tiers for onsite treatment systems (septic systems) were developed by the Bay Program's Point Source Workgroup. Tier 1 involved maintaining current septic concentrations/loads per system equivalent to 36 mg/l TN. Tier 2 includes 10% of new treatment systems installing NRTs to obtain an edge of drainage field TN concentration of 10 mg/l per system. Tier 2 for existing systems remains the same as Tier 1. TP levels are not addressed in the septic tiers because septics are not considered a significant source of phosphorus. Tier 3 involves 100% of new treatment systems installing NRTs to obtain an edge of drainage field TN concentration of 10 mg/l per system, and upgrades 1% of existing systems to this level of treatment as well. Note: the Point Source Workgroup felt strongly that the probability of retrofitting existing systems, due to the high costs, would not be likely, thus only 1% of existing systems were included in the Tier 3 scenario for retrofit. For E3, 100% retrofits and upgrades are defined for existing as well as new septics.

Nonpoint Source Agriculture

For most nonpoint source agricultural BMPs, implementation rates between 1997 and 2000 were continued to the year 2010 with limits that levels could not exceed the available or E3 land area to apply the BMPs to. The scale of the calculations was a county-segment or the intersection of a county political boundary and a model hydrologic segment. This is the same scale that most jurisdictions report BMP implementation levels to the Bay Program office.

2010 Tier 1 BMPs were extrapolated from recent implementation rates by the landuse types submitted by the states for each BMP. For example, if a jurisdiction submits data for nutrient management on crop, 2010 Tier 1 crop was projected and then split among high-till, low-till, and hay according to relative percentages. If a jurisdiction submits data as nutrient management on high-till, low-till, and hay individually, projections were done for each of these landuse categories.

The 2010 Tier 1 scenario does not include tree planting on tilled land, forest conservation, and forest harvesting practices as these BMPs are not part of the Tiers and E3. For forest harvesting practices and erosion and sediment control, the model simulation does not account for additional loads from disturbed forest and construction areas, respectively. For forest conservation, planting above what is removed during development is accounted for in the 2010 urban and forest projections. Tree planting on agricultural land was included in Tier 1 for pasture as forest buffers since this BMP is also part of the tiers and E3 and pasture tree planting and pasture buffers are treated the same in the model.

2010 Tier 2 and Tier 3 BMP implementation levels for non-point sources were generally determined by increasing levels above Tier 1 by a percentage of the difference between Tier 1 and E3 levels for each BMP. These percentages were mostly prescribed by individual source workgroups in the Bay Program Nutrient Subcommittee and were applied watershed-wide by county-segments or the intersections of county political boundaries and the Watershed Model's hydrologic segmentation.

The BMP levels in E3 are believed to be the maximum extent feasible. There are no cost and few physical limitations to implementing BMPs for both point and non-point sources. In addition, E3 includes new BMP technologies and programs that are not currently part of jurisdictional pollutant control strategies

Exhibit 5-2 provides examples of the increasing levels of BMP implementation by tier for agricultural BMPs.

Exhibit 5-2: Example Agricultural Nonpoint Source BMPs by Tier

Agricultural BMP	Tier 1	Tier 2	Tier 3	E3
Conservation Tillage	Continue current level of implementation	Applied to 30% of remaining cropland beyond Tier 1	Applied to 60% of remaining cropland beyond Tier 1	Conservation tillage on 100% of cropland
Cover Crops	Continue current level of implementation	Applied to 40% of remaining cropland beyond Tier 1	Applied to 75% of remaining cropland beyond Tier 1	Applied to 100% of cropland
Stream Protection w/fencing	Continue current level of implementation	Applied to 15% of remaining stream reaches within pasture land beyond Tier 1	Applied to 75% of remaining stream eaches within pasture land beyond Tier 1	Streambank protection on all unprotected stream miles (each side) associated with pasture

Nonpoint Source Urban

Tier 1 represents voluntary and regulatory storm water management programs that will be in place between 2000 and 2010 including: EPA NPDES Phase I and II storm water regulations, the construction and effluent development guidelines, and state storm water management programs.

Tiers 2 and 3 represent progressively increased levels of voluntary BMP implementation measures beyond Tier 1. E3 represents the Nutrient Subcommittee's Urban Storm Water Workgroups understanding of the highest levels of urban BMP protection achievable. **Exhibit 5-3** provides some examples of the urban BMP tiers.

Exhibit 5-3: Example Urban Nonpoint Source BMPs by Tier

Urban BMP	Tier 1	Tier 2	Tier 3	E3
Storm Water Management—recent development (1986–2000)	60% of recent development has storm water management	Same as Tier 1	Same as Tier 1	See E3 for "recent and old development" below
Storm Water Management - new development (2001–2010)	66% of new development has storm water management	75% of new development has storm water management; 25% of new development has LID*	50% of new development has storm water management; 50% of new development has LID*	100% of new development has LID*
Storm Water Management—-recent and old development (pre 1986)	0.8% of recent and old development is retrofitted	5% of recent and old development is retrofitted	20% of recent and old development is retrofitted	100% of recent and old development is retrofitted

*Low Impact Development

Nonpoint Source Forestry

The forestry BMP levels defined in the tiers are the same throughout all four levels. It is assumed that forestry BMPs are designed to minimize the environmental impacts from timber harvesting such as road building and cutting/thinning operations, and are properly installed on all harvested lands with no measurable increase in nutrient and sediment discharge. The assumption is based on maintaining the state of forest loads as measured during the calibration of the Bay Program Watershed Model.

Atmospheric Deposition

The Chesapeake Bay Program modeled four different nitrogen oxide (NOx) emission reduction scenarios (**Exhibit 5-4**) to estimate changes in atmospheric nitrate deposition and loading to the Bay and to determine attainability of proposed water quality standards for the Bay. The first two scenarios describe Clean Air Act (CAA) regulations that have passed; the third and fourth scenarios include these regulations, as well as emissions controls that are not tied to existing or proposed regulations. All scenarios involve NOx emissions reductions made by 37 states contained in the RADM domain.

Exhibit 5-4: Tiers and NOx Reduction Assumptions
Based on 1990 NOx Emissions Inventory (note that tiers are inclusive)

Tier 1	Tier 2	Tier 3	E3
NOx State Implementation Plans (SIPs), assuming implementation by 2007/2010 2007 non-utility and area source emissions 2007 mobile source–Tier 2 tailpipe standards on Light Duty Vehicles (LDVs) (cars and trucks) 2010 utility emissions—Title IV (acid rain) fully implemented and Title I 20-state NOx SIP call seasonal (May-Sept) ozone controls.	Tier 1 controls, plus heavy duty diesel vehicle (HDDV) regulations, assuming implementation by 2020. 2020 non-utility and area source emission standards. 2020 Tier 2 tailpipe standards on LDVs 2020 Title V and Title I NOx SIP HDDV Regulations	Tier 1 and 2 controls, plus "what if"aggressive utility controls, assuming implementation by 2020 2020 non-utility and area source emission standards 2020 Tier 2 tailpipe standards on LDVs 2020 Title V and Title I Nox SIP greater emissions reductions from utility sector-annual controls	Tier 1-3 controls, plus "what if" more industry and mobile source controls, assuming implementation by 2020. 2020 non-utility and area source emissions Industry (non-utility) emissions at almost 50% for both SO2 and Nox 2020 Title V and Title I Nox SIP greater emissions reductions from utility sector-annual controls Super ultra-low emission vehicle assumed for LDVs.

Load Reductions by Tier

The tier and E3 scenarios were simulated by the Bay Program's Phase 4.3 Watershed Model and the resultant loads for nitrogen, phosphorus, and sediment were used as inputs to the Chesapeake Bay Estuary Model. Evaluation of clarity and DO and chlorophyll-a concentrations from the Estuary Model, in turn, provided a sense of the response of these key water quality parameters to the various loading levels.

For the tiers, BMP implementation levels, the resultant modeled loads, and the measured responses in tidal water quality are informational. They are not intended to prescribe control measures to meet Chesapeake 2000 nutrient and sediment loading caps.

Relating BMP implementation levels in the tier scenarios to water quality responses only provides examples of what degrees of effort achieve the reported loads and what the water quality responses are to those loading levels. Reported E3 loads from the Bay's basin; however, can imply measurable theoretical minimums that would be extremely difficult, if not impossible, at this time to remedy.

Exhibits 5-5 to **5-7** depict modeled nutrient and sediment loads delivered to the Chesapeake Bay for the E3 scenario, with all tier loads, the Pristine Conditions scenario (See Section 3) and the Bay Program's current modeled estimates of loads for the year 2000 as references.

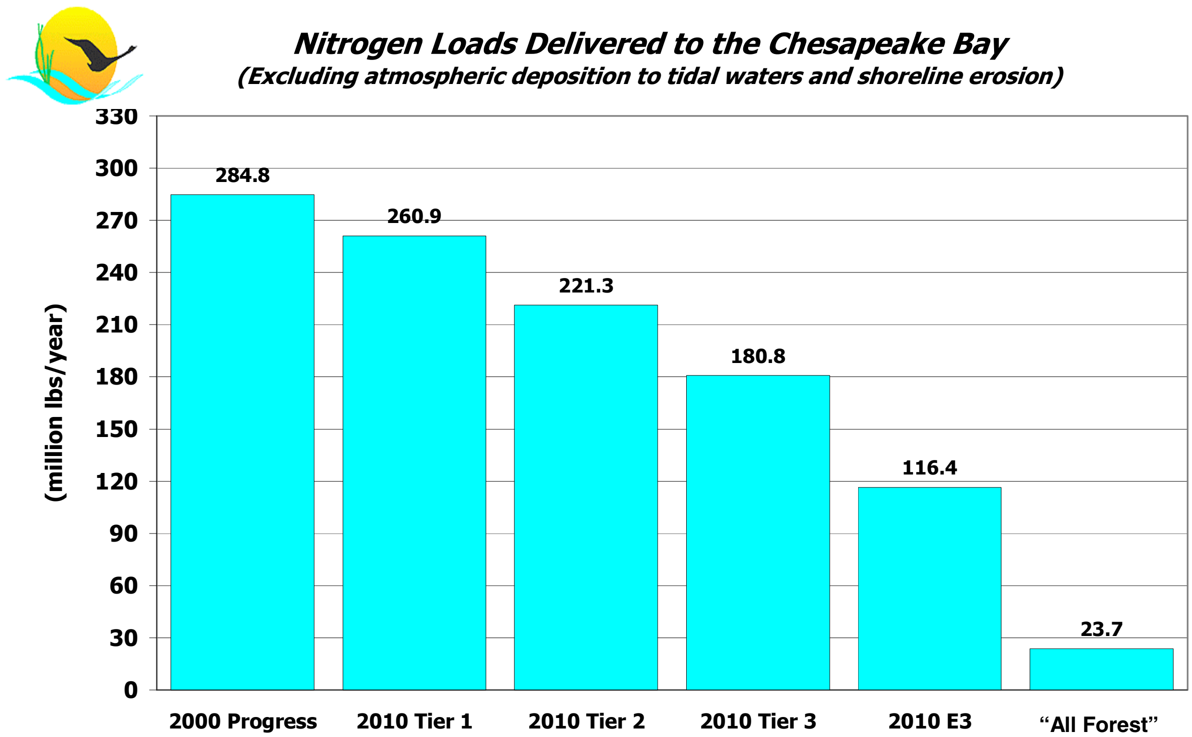

Exhibit 5-5: Nitrogen Loads Delivered to the Chesapeake Bay

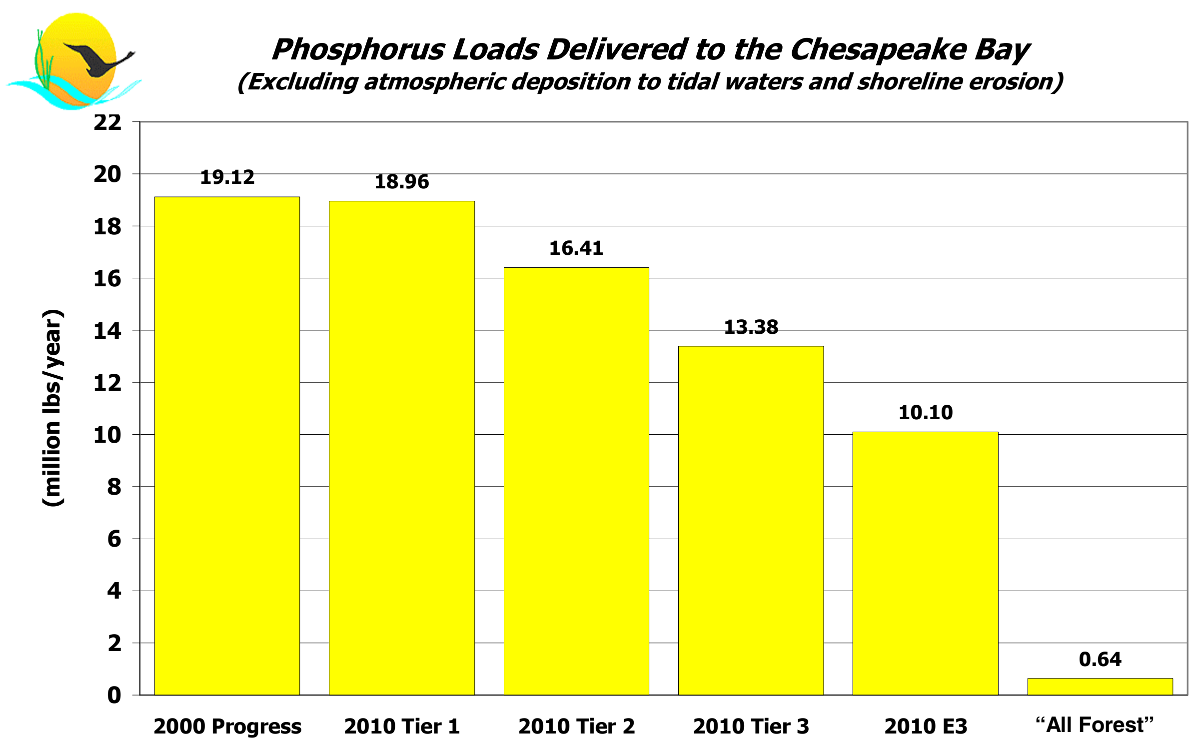

Exhibit 5-6: Phosphorus Loads Delivered to the Chesapeake Bay

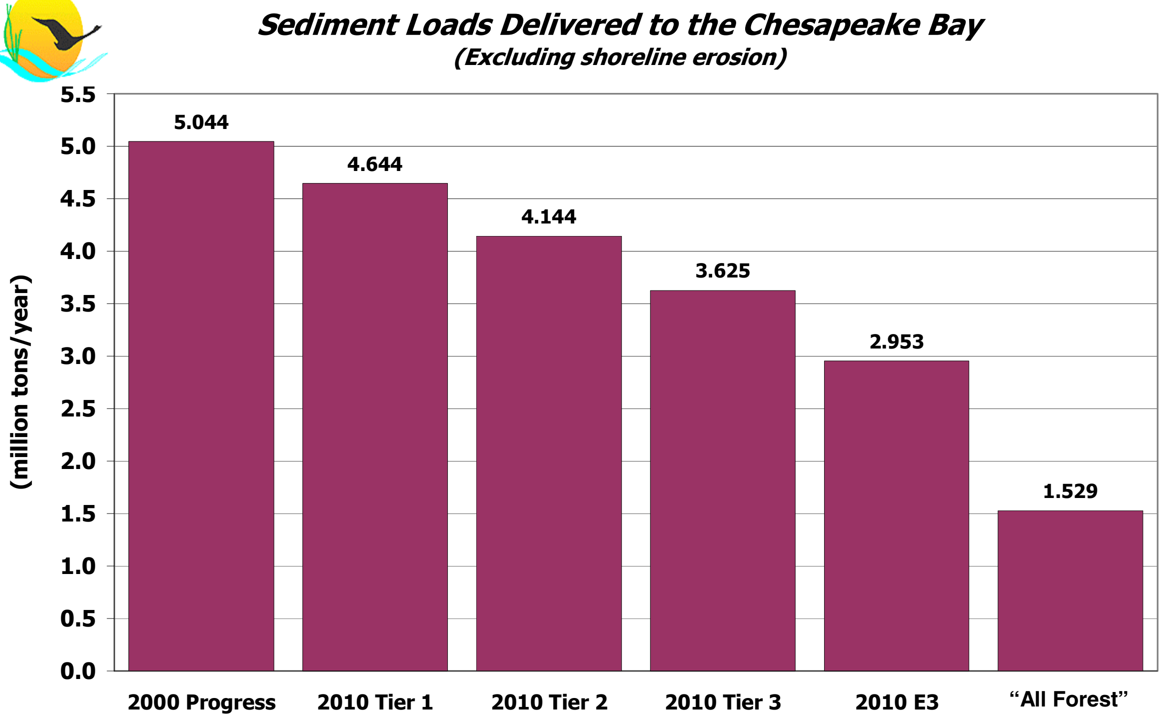

Exhibit 5-7: Sediment Loads Delivered to the Chesapeake Bay

5.1.2 Development of Attainability Tables

A series of Chesapeake Bay airshed/watershed/water quality model scenarios were run to determine the water quality response to the reduction actions represented in each tiered scenario. The results of these analyses are presented in a series of technological "attainability tables" which show, on a Chesapeake Bay Program segment by segment basis, the level of attainment of the applicable Bay criteria by designated use by tiered scenario. The model simulated percent criteria attainment, illustrated in the attainability tables which follow, are based on an integrated evaluation of Chesapeake Bay model simulated output and water quality monitoring observed data. For a full discussion of this integration procedure, see *A Comparison of Chesapeake Bay Estuary Model Calibration with 1985 - 1994 Observed Data and Method of Application to Water Quality Criteria* (Linker et al. 2002). Results are presented for the 35 major Chesapeake Bay Program segments where management applicable model results are available.

EPA solicits public comments on this approach to assessing attainability.

These attainability tables were developed based a comprehensive set of criteria attainment determination procedures described in detail in *Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for Chesapeake Bay and its Tidal Tributaries* (US EPA 2003). In general, modeled DO water quality observations were compared to proposed criteria, on a segment by segment basis (see Exhibit 4-8 for a description of the water quality monitoring segments) to determine the spatial and temporal extent of non-attainment. The criteria used to conduct these comparisons were a DO concentration monthly average of 6 mg/l for the migratory and spawning use, 5 mg/l for the open water use, 3 mg/l for the deep water use, and 1 mg/l for the deep channel use. At this time, the attainability tables do not reflect the 7-day or instantaneous criteria.

5.1.2.1 Developing the Cumulative Frequency Distribution

Cumulative Frequency Diagrams (CFD's) are the foundation for the derivation of the attainability tables. These curves were used to assess water-quality criteria "exceedance" (or non-attainment based on the monthly average DO concentrations specified by designated use) in the Chesapeake Bay. Some spatial and temporal criteria exceedances which are observed do not have serious effects on ecological health or on the designated use of a portion of the Bay. Such exceedances are referred to as "allowable exceedances." Even when water quality is restored in Chesapeake Bay, certain areas will exceed the Chesapeake Bay criteria, either due to poor flushing (chlorophyll *a*), a strong stratification event (DO), a wind resuspension event (water clarity) or some other natural phenomenon. A reference curve should reflect expected exceedances that occur naturally when the biological community is not impaired by the stressor(s) the criteria were designed to limit. Traditional regulatory assessments take 10% of the samples collected at a point and consider this amount to be "allowable exceedances" that have limited impact on the designated use. The 10% principle is not directly applicable in the context of the CFD methodology use herein for defining criteria attainment because it was designed for samples collected at one location and is only reflective of time variations.

CFD's offer the advantage of allowing the evaluation of both spatial and temporal variations in criteria exceedance. Methods currently used for the assessment of criteria attainment are based only on frequency of exceedances because measurements are usually evaluated only at individual locations. In a waterbody the size of the Chesapeake Bay, accounting for spatial variation can be important and in that respect, the CFD approach represents a significant improvement over methods used in the past. Development of a CFD is accomplished by first quantifying the spatial extent of criteria exceedance for every monitoring event during the assessment period. The compilation of estimates of spatial exceedance through time provides the capability to account for both spatial and temporal variation in criteria exceedance. Assessments are performed within spatial units defined by the intersection of monitoring segments and designated uses, and temporal units of 3-year periods. Thus individual CFD's are developed for each spatial unit over three-year assessment periods. Details of the development of CFD's are described in the EPA Criteria Document (U.S. EPA, 2003).

The CFD is a graphical summary of criteria exceedance created by plotting temporal frequency on the vertical axis and spatial extent on the horizontal axis (**Exhibit 5-8**). The resulting figure can be used in a number of ways to draw conclusions about the extent and pattern of criteria attainment or exceedance. The area under the curve represents a spatial and temporal composite index of criteria exceedance that is biologically acceptable and is used as the basis for defining criteria attainment for all Chesapeake Bay segments and designated uses.

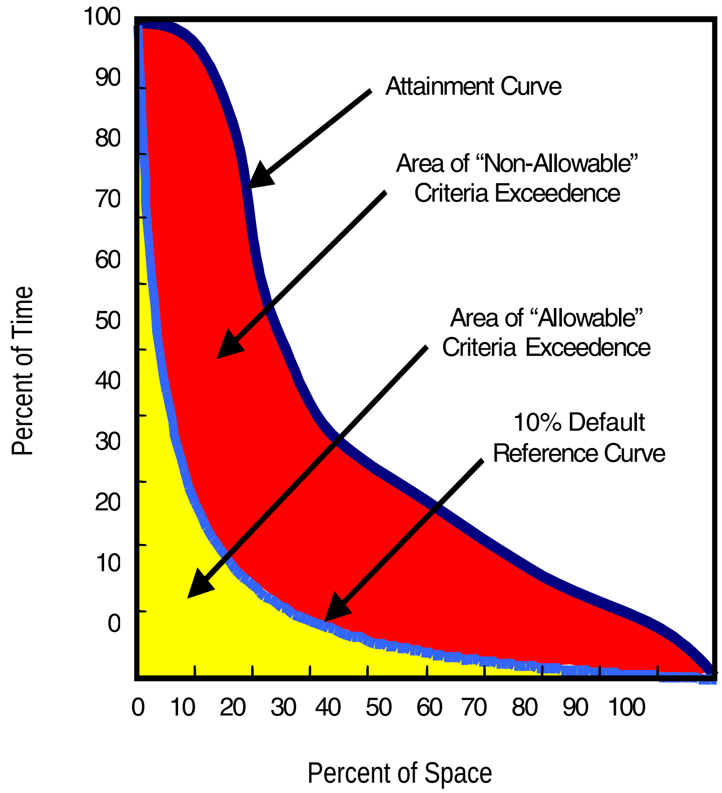

Exhibit 5-8: Interpretation of Cumulative Frequency Diagram for Water-Quality Criteria Attainment

Note that in Exhibit 5-8 the yellow (or grey in black and white copies) area reflects amount of "allowable" criteria exceedance defined as the area under the reference curve (light blue in color copies), the red area (or dark grey) reflects the amount of "non-allowable" criteria exceedance defined as the area between the attainment curve and the reference curve.

A more appropriate approach for defining "allowable exceedances" in the CFD context is to develop a "reference" curve as described above that identifies the amount of spatial and temporal criteria exceedance that can occur without causing ecological degradation. Such curves are based on biological indicators of ecological health that are separate from the criteria measures themselves. Biological indicators are used to identify areas of the Bay that have healthy ecological conditions. CFD's developed for those areas would reflect an extent and pattern of criteria exceedance that did not have ecological impact. In that way the reference curve approach takes the development of criteria levels beyond those developed in a laboratory setting and provides actual environmental context (U.S. EPA, 2003).

The use of the reference curve and the interpretation of criteria attainment using the CFD is illustrated in Exhibit 5-8. The light blue (or bottom) line in the figure illustrates a possible reference curve, below which a certain amount of spatial or temporal exceedance is allowed. The dark blue (or upper) line is an attainment curve, which is developed over every assessment period during which monitoring data are collected. The attainment curve is the assessment of the condition in the segment and it is compared to the reference curve, which serves as the benchmark. The area above the reference curve and below the attainment curve is the measure of criteria attainment and is referred to as "non-allowable exceedances."

5.1.2.2 Use of the "10% Default Reference Curve" Versus Biological Reference Curves

For most criteria components and designated uses, biologically-based reference curves are the preferred benchmark for evaluating CFDs and for defining the extent and pattern of allowable exceedances. However, biological information is not available for all cases and for those situations a default reference curve is needed. The default reference curve (sometimes referred to as the "thin blue line"), was developed based on two principles: 1) limiting the amount of allowable exceedance to 10% of time and space combined; and 2) showing no preference for either spatial or temporal exceedance. The curve used for this purpose is a simple inverse curve that is forced through the 100% levels of temporal and spatial exceedance. In most cases, the biological references curves that have been developed are very similar to the default curve and it is considered to be a reasonable approach on that basis. However, actual biologically-based reference curves are the preferred approach and are used wherever possible (U.S. EPA, 2002).

It is important to note that the attainability tables shown in **Exhibits 5-9** and **5-10** are based on the 10% default reference curve and not on the biological reference curves. The biological reference curves are currently being developed and applied by the Chesapeake Bay Program and the attainability results will be reevaluated using these curves during the comment period and results will be presented in April 2003. Preliminary results using the biological reference curves are that the percent non-attainment *decreases* for all uses.

5.2 TECHNOLOGICAL ATTAINABILITY RESULTS

The results of the analyses are presented in a series of attainability tables (**Exhibits 5-9** and **5-10**). The "Observed" column in the table represents current conditions that exist in the Bay now and were derived from monitoring data. The letter "A" in the tables denotes attainment (i.e., 0% non-attainment), and the numbers represent percent non-attainment for each segment as determined using the 10% default CFD reference curve described above. The analyses presented in this section will show that, with the exception of a few segments in the Bay, the DO criteria protecting of the designated uses are attained by reductions represented by the E3 scenario. For Tier 3, the analysis shows that the DO criteria protecting designated uses in some segments, particularly for deep water uses in certain mainstem segments, do not achieve full attainment.

Exhibit 5-9: Summary of Migratory and Spawning DO Percent Non-Attainment at 6 mg/l Monthly Average*

Segment	Observed	Tier 2	Tier 3	EEE
CB1TF	A	A	A	A
CB2OH	A	A	A	A
CB3MH	0.7	A	A	A
CHOMH1	A	A	A	A
CHOMH2	A	A	A	A
CHOOH	A	A	A	A
CHSMH	A	A	A	A
EASMH	A	A	A	A
JMSMH	A	A	A	A
JMSOH	A	A	A	A
JMSTF	A	A	A	A
MPNOH	0.86	A	A	A
MPNTF	A	A	A	A
PAXMH	0.31	A	A	A
PAXOH	0.49	A	A	A
PAXTF	A	A	A	A
PMKOH	0.16	A	A	A
PMKTF	A	A	A	A
POTMH	A	A	A	A
POTOH	A	A	A	A
POTTF	A	A	A	A
RPPMH	A	A	A	A
RPPOH	A	A	A	A
RPPTF	A	A	A	A
YRKMH	0.88	A	A	A

* A = Attainment, the numbers provide estimates of % non-attainment

Exhibit 5-10: Summary of DO Percent Non-Attainment for Open Water, Deep Water, and Deep Channel*

Segment	Designated Use	Observed	Tier 2	Tier 3	EEE
CB1TF	Open Water	A	A	A	A
CB2OH	Open Water	0.76	A	A	A
CB3MH	Open Water	7.61	1.99	0.7	A
	Deep Water	40.28	17.19	6.56	A
	Deep Channel	40.27	8.08	A	A
CB4MH	Open Water	6.25	2.63	1.21	A
	Deep Water	48.35	31.6	20.3	A
	Deep Channel	62.74	16.93	A	A
CB5MH	Open Water	A	A	A	A
	Deep Water	12.59	2.23	0.01	A
	Deep Channel	15.5	A	A	A
CB6PH	Open Water	6.26	1.52	0.09	A
	Deep Water	18.24	3.36	A	A
CB7PH	Open Water	4.84	0.89	0.01	A
	Deep Water	3.71	A	A	A
CB8PH	Open Water	A	A	A	A
CHOMH1	Open Water	0.96	0.19	0.02	A
CHOMH2	Open Water	1.18	A	A	A
CHOOH	Open Water	0.04	A	A	A
CHSMH	Open Water	2.59	0.42	0.02	A
	Deep Water	29.83	18.88	7.83	A
	Deep Channel	22.15	A	A	A
EASMH	Open Water	2.73	1.49	0.72	A
	Deep Water	56.12	40.1	30.93	5.66
	Deep Channel	37.47	4.15	A	A
ELIPH	Open Water	7.83	A	A	A
	Deep Water	A	A	A	A
	Deep Channel	A	A	A	A
JMSMH	Open Water	A	A	A	A
JMSOH	Open Water	A	A	A	A
JMSPH	Open Water	0.02	A	A	A

Exhibit 5-10: Summary of DO Percent Non-Attainment for Open Water, Deep Water, and Deep Channel*

Segment	Designated Use	Observed	Tier 2	Tier 3	EEE
JMSTF	Open Water	A	A	A	A
MOBPH	Open Water	1.17	A	A	A
MPNOH	Open Water	49.13	A	A	A
MPNTF	Open Water	16.61	A	A	A
PAXMH	Open Water	15.43	3.28	0.44	A
	Deep Water	14.53	2.14	0.12	A
PAXOH	Open Water	10.91	0.05	A	A
PAXTF	Open Water	0.01	A	A	A
PIAMH	Open Water	0.02	A	A	A
PMKOH	Open Water	44.15	A	A	A
PMKTF	Open Water	44.59	A	A	A
POCMH	Open Water	A	A	A	A
POTMH	Open Water	8.77	3.11	1.73	A
	Deep Water	34.65	19.88	9.68	A
	Deep Channel	24.1	0.78	A	A
POTPH	Open Water	0.82	A	A	A
POTTF	Open Water	0.05	A	A	A
RPPMH	Open Water	1.23	A	A	A
	Deep Water	2.41	0.07	A	A
	Deep Channel	1.71	A	A	A
RPPOH	Open Water	A	A	A	A
RPPTF	Open Water	A	A	A	A
SBEMH	Open Water	60.72	A	A	A
TANMH	Open Water	A	A	A	A
YRKMH	Open Water	20.45	A	A	A
YRKPH	Open Water	8.43	A	A	A
	Deep Water	2.56	A	A	A

*A = Attainment, Analysis based on 5 mg/l, 3 mg/l, and 1 mg/l monthly DO averages for Open Water, Deep Water, and Deep Channel respectively

5.2.1 Migratory Fish and Spawning and Nursery Designated Use Attainability

As indicated by Exhibit 5-9 which shows the percent of non-attainment for a monthly average DO concentration of 6 mg/l in the Migratory and Spawning Designated Use, attainment is virtually achieved now in all segments that include this use in the Bay. The results are to be expected as these segments are those in the tidal fresh parts of the Bay where the constant flow and mixing of these waters promotes continual oxygenation. Certainly the implementation of additional reductions expected by current voluntary and regulatory programs by 2010 will eliminate the small amount of non-attainment shown in some of the segments under the observed column. Thus, as these results show, this Migratory Fish Spawning and Nursery Designated Use can essentially be attained under current conditions, or will be under planned implementation actions, and should not be an issue in the near future as long as responsible pollution prevention and control measures are maintained.

5.2.2 Shallow Water Bay Grass Designated Use Attainability

Attainability with respect to the DO criteria is addressed below in Section 5.2.3 because the 5 mg/l monthly average DO criterion is the same for both the shallow as well as open water uses. Attainability based on the clarity criteria is not addressed in this TSD document at this time, but will be explored during the comment period and results will be presented in the April 2003 final version.

5.2.3 Open Water Fish and Shellfish Designated Use Attainability

Exhibit 5-10 presents the results of the attainability analyses for DO monthly averages of 5, 3, and 1 mg/l respectively for Open Water, Deep Water and Deep Channel (the Open water use in this table also includes shallow water uses with respect to DO). As indicated by this table, full attainment is rare for Open Water under observed conditions. However, at Tier 3, attainment for most segments is achieved for this refined designated use. In all cases where non-attainment is indicated for Open Water at Tier 3, it is a non-attainment percentage of less than 2%, and in some cases less than 1%. It will be up to the jurisdictions during the development of their individual UAAs, to determine the significance of any degree of non-attainment. For example, a jurisdiction may determine that a non-attainment of 0.7%, as shown in segment CB3MH Open Water, is not significant, and reduction levels represented by Tier 3, will be sufficient to achieve attainment. Complete attainment is illustrated at reduction levels equal to E3 for Open Water.

5.2.4 Deep Water Seasonal Fish and Shellfish Designated Use Attainability

As also illustrated by Exhibit 5-10, the Deep Water designated use for DO is not currently attained in any of the segments of the Bay under observed conditions. Some degree of attainment is seen at reductions levels equivalent to Tier 2. At Tier 3, non-attainment persists in several major segments of the Bay. Attainment is achieved in virtually all of the segments at reduction levels represented by E3 (except for a 5.66% non-attainment in the Eastern Bay).

Based on the results of these attainability analyses, the Deep Water designated use appears to be the most difficult use to achieve of all of the uses. Scientific reasons for this will be further explored during the comment period and results presented upon completion in April 2003. Particular segments of note that exhibit relatively high levels of non-attainment at Tier 3 include the mainstem segment CB4MH just above the Patuxent River but below the Chester River, EASMH in Eastern Bay, CHSMH in the Chester River, and POTMH in the Potomac River. It may be that there are physical and hydrologic reasons for these non-attainment areas such that the geographical extent, and perhaps the vertical extents of the use boundaries are not yet positioned properly. Further exploration of the geographical appropriateness of the boundary delineations based on the natural and physical conditions and hydrology of the Bay will be conducted during the comment period and final results presented by April 2003.

5.2.5 Deep Channel Seasonal Refuge Designated Use and Seasonal Anoxic Regions Attainability

Exhibit 5-10 further illustrates that the proposed criteria for DO for the Deep Channel use are not attained under observed conditions. However, the percent non-attainment decreases with increasing load reductions, until 100% attainment is achieved at levels equal to E3. Even at levels of reduction represented by Tier 3, almost complete attainment is achieved.

5.3 NEXT STEPS FOR ATTAINABILITY ANALYSES TECHNICAL SUPPORT

Some aspects of the attainability analysis will be refined and revised during the comment period and results will be presented in April 2003. The following is a list of areas where further work is being explored.

EPA solicits comments on additional areas where attainability analyses can be improved.

5.3.1 Application of the Kolmogorov-Smirnov Test for Criteria Attainment Using the CFD

In cases where the amount of "non-allowable exceedances" is large, decisions regarding the attainment of designated uses will be clear and unequivocal. However, it is conceivable that situations could arise where small amounts of non-allowable exceedance could make the decisions less clear. In such situations there could always be a question about the level of certainty in the analysis and whether the data were adequate to determine that the portion of the Bay was not attaining its designated use. It is possible to define the decision guideline such that <u>any</u> non-allowable exceedance would indicate non-attainment of the established designated use. However, a decision guideline based on a statistical test could help to address some of the uncertainty involved by accounting for differences in the number of observations on which the analysis is based.

Work is currently underway to devise a statistical test for the application of CFDs to assess water-quality criteria attainment in the Chesapeake Bay. The test currently being evaluated and refined is the Kolmogorov-Smirnov (KS) test, which was originally developed to test for significant differences between cumulative density functions. The KS test is nonparametric (not dependent on a normal distribution of the data) and is based on the maximum difference between curves. The maximum difference is somewhat different than the area between the curves, which is the preferred indicator for assessing attainment. However, it can be shown that the maximum difference and the area between the curves are closely correlated and therefore evaluation of one will reflect an evaluation of the other. An advantage of the KS test is that it is well documented and accepted in the statistical literature. Some refinements may be necessary and those are currently being evaluated. However, the KS test appears to offer strong potential for the purpose of evaluating water-quality criteria attainment in the Chesapeake Bay (U.S. EPA, 2003).

5.3.2 Consideration of Different Hydrology Periods

Currently, the CFD curves are generated from ten years (1985–1994) of data and model output to assess attainment and non-attainment of criteria in model scenarios. However, compliance monitoring of the criteria adopted by the states may be performed using a more traditional three-year hydrology. The Bay Program will be evaluating the use of three-year rolling averages for non-attainment of the criteria in the model scenarios as the basis for the CFD curves and will present the results in April 2003. This may also affect the attainability result and any changes will also be presented.

5.3.3 Use of Biological Reference Curves

As discussed under Section 5.1.2, the evaluation of CFD curves used to assess criteria attainment were based on application of the 10% default reference curve. The WQSC has determined that it is preferable to develop these curves based on biological reference curves. Thus, attainability will be reassessed after biological reference curves are developed.

5.3.4 Use of Different Criteria Averaging Periods

As previously noted, these attainability analyses are performed using monthly average DO concentrations for each designated use. Monthly averaging periods were used in this analysis because they reflect the best data available. The Bay Program will continue to explore conducting these analyses on additional averaging periods specified by the criteria (instantaneous minima and seven-day means) to the extent that information is available to do so.

5.3.5 Sediment Reductions and its Effect on Water Quality

It has recently been discovered that reductions of sediment, beyond what nutrient reduction measures alone can afford, may have a positive correlation to improvement in ambient DO water quality. This could have huge ramifications on attainability if sediment reductions, not accounted for in the tiers, could affect the percent non-attainment in the attainment tables presented in Section 5.2.

Model estimates show reductions in shoreline sediment loads have a significant influence in improving DO in the Deep Water and Deep Channel portions of water quality monitoring segments. Sediment load reductions can also have positive effects on water clarity in the Shallow water areas. Work is underway to examine the degree and cause of the observed sediment interactions. Greater sequestering and retention of nutrients in the shallows may be due to increased SAV and benthic algae in the shallows (caused by improved light conditions resulting from reduced sediment). Decreases in shoreline sediment loads in the shallows would also have a positive effect on benthic filter feeders, which may also cause greater nutrient retention in shallow sediment. Simulated shoreline sediment loads are associated with soil phosphorus loads as well as negligible nitrogen loads, and the contributing effect of these nutrient reductions associated with shoreline sediment reductions needs to be assessed as well.

Tidal sediment reductions measures (i.e., shoreline erosion) have not been included in the load reduction tiers, nor have they been costed. Work in this area will continue and results presented in April 2003.

5.3.6 How Different Major Basins Influence Other Major Basins

It is known that nutrient reductions in some tributaries will have more of an effect on the Bay (or other tributaries) than reductions elsewhere. (The Bay and its tributaries are affected differently by other tributaries in such a way as to make one or more tributaries more effective in realizing water quality responses to given reduction scenarios relative to other tributaries.) As an example, the water quality of the Bay mainstem is affected more by reduction actions implemented in the Potomac and tributaries north of it than by the tributaries south of the Potomac.

The water quality response in relation to reduction measures performed in different parts of the Bay is being explored to understand where it is most effective to effect reductions. Nitrogen, phosphorus and sediment loads originating in different tributaries have a differential impact on achievement of water quality criteria. These distinctions can be caused by the magnitude of the loads, hydrographic and geographic considerations, or the particular nutrient dynamics local to the assessment area. A series of geographic isolation scenarios are being developed by the Chesapeake Bay Program in an effort to understand which watersheds affect which areas of the bay and by how much. Results of this work may also positively influence attainability as we learn where the most efficient reductions, from a basin impact perspective, can come from. Work in this area will continue and results, as it relates to attainability, will be presented in April 2003.